

REMARKS

Applicant respectfully requests reconsideration of the present application in view of the foregoing amendments and in view of the reasons which follow.

Claims 2, 4, and 20 have been cancelled.

Claims 1, 5, 7, 10, 12, and 15 have been amended.

After amending the claims as set forth above, claims 1, 3, and 5-19 are now pending in this application.

Rejection under 35 U.S.C. 102

In Section 3 of the Office Action, the Examiner rejected claims 1-20 under 35 U.S.C. 102(e) as being anticipated by U.S. Patent No. 6,770,559 (Adem et al.) filed on October 29, 2002. Applicant respectfully traverses the rejection. Adem et al. does not qualify as prior art.

The present application is a continuation of U.S. Application 10/123,751 filed on April 16, 2002, which is before the filing date of Adem et al. The claims in the present application have been amended to place them in the same condition as the claims of the parent application (now abandoned), which Applicant respectfully asserts overcomes the prior art presented in that application.

Inasmuch as Adem et al. does not qualify as prior art, Applicant respectfully requests withdrawal of the rejection.

Priority Claim

For the sake of clarity, Applicant presents the following sequence of events to demonstrate the continuity of the priority claim.

- On 9-18-2003, a final Office Action was mailed for U.S. Application 10/123,751.

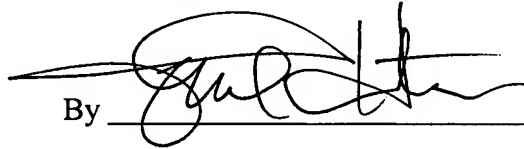
- On 11-19-2003, an Response was filed by Applicant to the Office Action of 9-18-2003 (copy attached hereto as Exhibit A).
- On 3-10-2004, Examiner Gourley called Applicant's representative, Paul S. Hunter, to inform him that a response was not received. The same day, Mr. Hunter faxed a copy of the filed Response to Examiner Gourley (copy of fax confirmation attached hereto as Exhibit B).
- On 3-18-2004, Applicant filed a continuation application claiming priority to U.S. Application 10/123,751.
- On 4-21-2004, a Notice of Abandonment (for U.S. App. 10/123,751) was mailed indicating that the proposed reply received on 3-14-2004 (the faxed copy of the Response of 11-19-2004) was not a proper reply under 37 C.F.R. 1.113.

A copy of the Response After Final mailed November 19, 2003 and the accompanying postcard stamped as received by the PTO are attached hereto as Exhibit A. According to M.P.E.P. 714.13, when a response to a final rejection is filed within two months of the mailing date of a final Office Action and the PTO does not mail an advisory action until after the three month time period set for response to the Office Action, the shortened statutory period expires on the date the advisory action is mailed but not beyond six months from the mailing of the final Office Action. Here, an Advisory Action was not sent. As such, the shortened statutory period expired six months from the final Office Action—March 18, 2004. Applicant's filing of the continuation application on March 18, 2004, therefore, qualifies for co-pending status with the parent application.

Applicant believes that the present application is now in condition for allowance. Favorable reconsideration of the application is respectfully requested. The Examiner is invited to contact the undersigned by telephone if it is felt that a telephone interview would advance the prosecution of the present application.

The Commissioner is hereby authorized to charge any additional fees which may be required regarding this application under 37 C.F.R. §§ 1.16 1.17, or credit any overpayment, to Deposit Account No. 50-2350. Should no proper payment be enclosed herewith, as by a check being in the wrong amount, unsigned, post-dated, otherwise improper or informal or even entirely missing, the Commissioner is authorized to charge the unpaid amount to Deposit Account No. 50-2350. If any extensions of time are needed for timely acceptance of papers submitted herewith, Applicant hereby petitions for such extension under 37 C.F.R. §1.136 and authorizes payment of any such extension fees to Deposit Account No. 50-2350.

Respectfully submitted,

By 

Date September 13, 2005

FOLEY & LARDNER LLP
Customer Number: 26371
Telephone: (608) 258-4292
Facsimile: (608) 258-4258

Paul S. Hunter
Attorney for Applicant
Registration No. 44,787

EXHIBIT A



THE U.S. PATENT AND TRADEMARK OFFICE
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Serial No.: 10/123,751

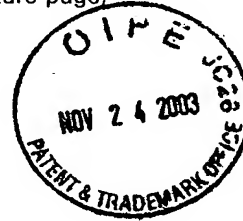
Applicants: Ercan Adem

Filed: April 16, 2002

Title: METHOD OF ULTRA-LOW ENERGY ION
IMPLANTATION TO FORM ALLOY LAYERS
IN COPPER

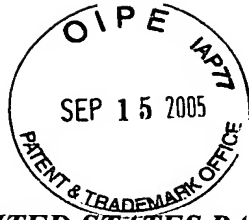
Date Mailed: November 19, 2003

- ☒ Amendment Transmittal (3 pages) (duplicate)
- ☒ Amendment and Reply (9 pages) (duplicate of
page 1 and signature page)



DOCKET NO.: 039153-0529

Atty.: PSH *jid*



Atty. Dkt. No. 039153-0529 (G1234)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Ercan Adem

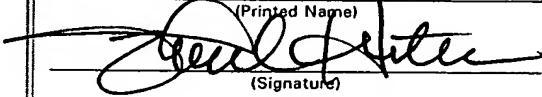
Title: METHOD OF ULTRA-LOW
ENERGY ION IMPLANTATION
TO FORM ALLOY LAYERS IN
COPPER

Appl. No.: 10/123,751

Filing Date: 04/16/2002

Examiner: Gurley, Lynne Ann

Art Unit: 2812

<p>CERTIFICATE OF MAILING</p> <p>I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as First Class Mail in an envelope addressed to: Commissioner for Patents, PO Box 1450, Alexandria, Virginia 22313-1450, on the date below.</p> <p><u>Paul S. Hunter</u> (Printed Name)</p> <p><u></u> (Signature)</p> <p><u>November 19, 2003</u> (Date of Deposit)</p>

AMENDMENT TRANSMITTAL

Mail Stop NON-FEE AMENDMENT
Commissioner for Patents
PO Box 1450
Alexandria, Virginia 22313-1450

Sir:

Transmitted herewith is an amendment in the above-identified application.

- ☐ Small Entity status under 37 C.F.R. § 1.9 and § 1.27 has been established by a previous assertion of Small Entity status.
- ☐ Assertion of Small Entity status is enclosed.
- ☒ The fee required for additional claims is calculated below:

Claims As Amended	Previously Paid For	Extra Claims Present	Rate	Additional Claims Fee
18	- 20 =	0 x	\$18.00 =	\$0.00
3	- 3 =	0 x	\$86.00 =	\$0.00
First presentation of any Multiple Dependent Claims: + \$290.00 =				\$0.00
CLAIMS FEE TOTAL =				\$0.00

- ☐ Applicant hereby petitions for an extension of time under 37 C.F.R. §1.136(a) for the total number of months checked below:

	EXTENSION FEE TOTAL:	<u>\$0.00</u>
	Statutory Disclaimer Fee under 37 C.F.R.	
<input type="checkbox"/> 1.20(d):	\$110.00	\$0.00
	CLAIMS, EXTENSION AND DISCLAIMER FEE	
	TOTAL:	<u>\$0.00</u>
<input type="checkbox"/>	Small Entity Fees Apply (subtract ½ of above):	<u>\$0.00</u>
	TOTAL FEE:	<u>\$0.00</u>

- ☐ Please charge Deposit Account No. 50-2350 in the amount of \$0.00. A duplicate copy of this transmittal is enclosed.

- ☐ A check in the amount of \$0.00 is enclosed.

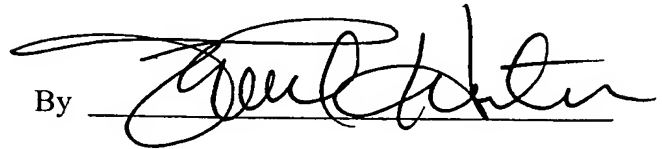
- ☒ The Commissioner is hereby authorized to charge any additional fees which may be required regarding this application under 37 C.F.R. §§ 1.16-1.17, or credit any overpayment, to Deposit Account No. 50-2350. Should no proper payment be enclosed herewith, as by a check being in the wrong amount, unsigned, post-dated, otherwise improper or informal or even entirely missing, the Commissioner is authorized to charge the unpaid amount to Deposit Account No. 50-2350. If any extensions of time are needed for timely acceptance of papers submitted herewith, applicant hereby petitions for such extension under 37 C.F.R. §1.136 and authorizes payment of any such extensions fees to Deposit Account No. 50-2350.

Please direct all correspondence to the undersigned attorney or agent at the address indicated below.

Respectfully submitted,

Date November 19, 2003

By

A handwritten signature in black ink, appearing to read "Paul S. Hunter", written over a horizontal line.

FOLEY & LARDNER

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Paul S. Hunter

Attorney for Applicant

Registration No. 44,787



Atty. Dkt. No. 039153-0529 (G1234)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Ercan Adem

Title: METHOD OF ULTRA-LOW ENERGY
ION IMPLANTATION TO FORM
ALLOY LAYERS IN COPPER

Appl. No.: 10/123,751

Filing Date: 04/16/2002

Examiner: Gurley, Lynne Ann

Art Unit: 2812

<p>CERTIFICATE OF MAILING</p> <p>I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as First Class Mail in an envelope addressed to: Mail Stop NON-FEE AMENDMENT, Commissioner for Patents, PO Box 1450, Alexandria, Virginia 22313-1450, on the date below.</p> <p><u>Paul S. Hunter</u> (Printed Name)</p> <p><u>[Signature]</u> (Signature)</p> <p><u>11/19/2003</u> (Date of Deposit)</p>
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AMENDMENT AND REPLY AFTER FINAL UNDER 37 CFR 1.111

Mail Stop NON-FEE AMENDMENT
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Sir:

This communication is responsive to the FINAL Office Action dated September 18, 2003, concerning the above-referenced patent application.

Please amend the application as follows:

In the Specification:

Please amend the specification as follows:

[0001] This application is related to U.S. Patent Application No. 09/994,358, ~~Attorney Docket No. 39153/455 (G1160)~~, entitled METHOD OF IMPLANTATION AFTER COPPER SEED DEPOSITION filed on November 26, 2001, which is assigned to the same assignee as this application.

[0010] An exemplary embodiment is related to a method of fabricating an integrated circuit. This method can include forming a barrier layer along lateral side walls and a bottom of a via aperture, forming a seed layer proximate and conformal to the barrier layer, and ion implanting elements into the seed layer. The via aperture is configured to receive a via material that electrically connects a first conductive layer and a second conductive layer.

In the Claims:

In accordance with 37 CFR § 1.121, please substitute for original claims 1-20, the following rewritten versions of the same claims, as amended.

Please amend the following claims:

1. (Currently Amended): A method of fabricating an integrated circuit, the method comprising:
forming a barrier layer along lateral side walls and a bottom of a via aperture, the via aperture being configured to receive a via material that electrically connects a first conductive layer and a second conductive layer;
forming a seed layer proximate and conformal to the barrier layer; and
ion implanting elements into the seed layer, wherein the elements can be any one of Zn, Sn, Cr, Ca, Ag, and In, wherein ion implanting elements into the seed layer comprises low energy ion implanting elements into the seed layer, wherein low energy ion implanting comprises implanting at an energy of 2.0 KeV or less.
2. (Cancelled)
3. (Original): The method of claim 1, further comprising selectively controlling concentration of the implanted elements.
4. (Cancelled)
5. (Previously Presented): The method of claim 1, wherein the ion implanting is at a dosage concentration of $1\text{E}15$ to $1\text{E}17$ atoms/cm².
6. (Original): The method of claim 1, further comprising tilting the integrated circuit thereby controlling placement of the implanted element on lateral side walls and the bottom of the via aperture.
7. (Previously Presented): The method of claim 1, further comprising using a thermal process to facilitate mixing of implanted elements and the seed layer.

8. (Original): The method of claim 1, wherein the seed layer has a cross-sectional thickness of between 50 and 1,000 Angstroms.

9. (Original): The method of claim 1, wherein the seed layer is formed by an angle implant to achieve a uniform distribution of elements.

10. (Currently Amended): A method of implantation after copper seed deposition in an integrated circuit fabrication process, the method comprising:
providing a first conductive layer over an integrated circuit substrate;
providing a conformal layer at a bottom and sides of a via aperture positioned over the first conductive layer to form a barrier separating the via aperture from the first conductive layer;
providing an ultra-low energy ion implant of any one of Zn, Sn, Cr, Ca, Ag, and In to form a seed layer over the conformal layer, wherein ultra-low energy ion implant occurs at an energy level of ~~20-9~~ 2.0 KeV or less;
filling the via aperture with a via material; and
providing a second conductive layer over the via material such that the via material electrically connects the first conductive layer to the second conductive layer.

11. (Original): The method of claim 10, wherein providing an ultra-low energy ion implant to form a seed layer over the conformal layer includes implanting a plurality of elements into the seed layer.

12. (Previously Presented): The method of claim 10, wherein providing an ultra-low energy ion implant to form a seed layer over the conformal layer includes providing an implant dosage concentration of $1\text{E}15$ to $1\text{E}17$ atoms/cm².

13. (Original): The method of claim 10, wherein providing an ultra-low energy ion implant to form a seed layer over the conformal layer includes providing an implant depth of 50 to 1,000 Angstroms.

14. (Original): The method of claim 10, wherein the seed layer has a cross-sectional thickness of 50 to 1,000 Angstroms.

15. (Currently Amended): A method of forming a via in an integrated circuit, the method comprising:

- depositing a first conductive layer;
- depositing an etch stop layer over the first conductive layer;
- depositing an insulating layer over the etch stop layer;
- forming an aperture in the insulating layer and the etch stop layer;
- providing a barrier material at a bottom and sides of the aperture to form a barrier layer;
- providing a seed layer over the barrier layer;
- providing a controlled low energy ion implantation of any one of Zn, Sn, Cr, Ca, Ag, and In into the seed layer, wherein low energy ion implantation comprises an energy level of 2.0 ~~20.0~~ KeV or less;
- filling the aperture with a via material.

16. (Original): The method of claim 15, wherein the ion implantation is at an angle of between 35 and 90°.

17. (Original): The method of claim 15, wherein control of ion implantation includes tilting the seed layer.

18. (Original): The method of claim 15, wherein the ion implantation into the seed layer includes B, P, or Ge elements.

19. (Original): The method of claim 15, wherein the barrier layer is Ta, TaN, or TiN.

20. (Cancelled)

REMARKS

Applicant respectfully requests reconsideration of the present application in view of the foregoing amendments and in view of the reasons which follow.

After amending the claims as set forth above, claims 1, 3, and 5-19 are now pending in this application.

Specification

In Section 2 of the Office Action, the disclosure is objected to because of various informalities. By this Amendment, paragraph [0001] is amended to remove the attorney docket information. Paragraph [0010] is amended to add a left bracket: "[0010]." Applicant believes the Specification has been corrected and respectfully requests withdrawal of the objection.

Rejection - 35 U.S.C. § 102

In Section 7 of the Office Action, claims 1, 5, and 7 are rejected under 35 U.S.C. § 102(e) as being anticipated by U.S. Application No. 2002/0115292 (Andricacos). Applicant respectfully traverses the rejection. Andricacos fails to disclose the claimed invention as recited in claims 1, 5, and 7. Applicant also reserves the right to swear behind Andricacos.

Independent claim 1 has been amended to include the limitations of claim 2 and has been amended to specify the implanting energy level at 2.0 KeV or less. This amendment is supported by at least by paragraph [0040] in the present application. Applicant's claimed invention recited in claim 1 has the advantageous feature of using low energy levels during implantation.

Claim 1, as amended, recites:

ion implanting elements into the seed layer, wherein the elements can be any one of Zn, Sn, Cr, Ca, Ag, and In, wherein ion implanting elements into the seed layer comprises low energy ion implanting elements into the seed layer, wherein low energy ion implanting comprises implanting at an energy of 2.0 KeV or less.

Andricacos does not disclose implanting at an energy level of 2.0 KeV or less. Andricacos suggests that Sn, In, or Cr ions can be implanted from 10 KeV to about 600 Kev. (See, Para [0062].) Applicant respectfully submits that 2.0 KeV or less is not on the order of 10 KeV. Accordingly, Andricacos et al. does not anticipate claims 1, 5 and 7. Applicant respectfully requests withdrawal of the rejection.

Rejection - 35 U.S.C. § 103

In Section 10 of the Office Action, claims 2-4, 6 and 8-20 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Andricacos in view of U.S. Patent No. 6,015,749 (Liu). Applicant respectfully traverses the rejection. Neither Liu nor Andricacos alone or in combination disclose, suggest, or teach the claimed invention as recited in claims 2-4, 6, and 8-20, as amended.

Claim 10, as amended, recites:

providing an ultra-low energy ion implant of any one of Zn, Sn, Cr, Ca, Ag, and In to form a seed layer over the conformal layer, wherein ultra-low energy ion implant occurs at an energy level of 2.0 KeV or less;

Claim 15, as amended, recites:

providing a controlled low energy ion implantation of any one of Zn, Sn, Cr, Ca, Ag, and In into the seed layer, wherein low energy ion implantation comprises an energy level of 2.0 KeV or less;

As discussed above, Andricacos does not provide any teaching for implanting ions at ultra low energy levels of 2.0 KeV or less. The Examiner on page 7 of the Office Action suggests that "An energy level of 20 KeV or less (in particular 10 to 20 KeV) would be on the order of 30 KeV to one of ordinary skill in the art." Regardless of whether or not that suggestion is true (to which Applicant does not comment), 2.0 KeV or less is clearly not on the order of 10 KeV or 30 KeV to one of ordinary skill in the art. As such, one of ordinary skill would not find it obvious to use the ultra low energy levels in light of Andricacos.

Liu describes a specific structure – a Cu₃ Ge intermettalic layer – that provides improved adhesion with a copper interconnect (see Col. 2, lines 42-45). Germanium ions are implanted at the interface of the seed layer and underlying layer (see Col. 4, lines 15-18). Liu teaches:

The germanium ion implantation procedure, is performed at an energy between about 30 to 500 KeV, at a dose between about 1E15 to 5E16 atoms/cm², and at an implant angle between about 0 to 20 degrees.

(Col. 4, lines 18-22, emphasis added.)

Liu only describes implanting Ge at 30 to 500 KeV (see Col. 4, lines 18-20). There is no suggestion of implanting other elements at ultra low energy levels (e.g., 2.0 KeV or less). It is important to note that the range given by both Liu and Andricacos include the range of 30 to 500 keV, but neither give any suggestion or teaching of using the ultra low energy levels .

Claims 4 and 20 have been cancelled without prejudice. Claims 3, 6, and 8-9 depend from claim 1, claims 11-14 depend from claim 10 and claims 16-19 depend from claim 15. Claims 1, 10, and claim 15 require implantation at energy levels of 2.0 KeV or less. Andricacos does not teach or suggest using these energy levels, nor does Liu et al. As such, there is no suggestion for the implanting energy level claim limitations recited in claims 1, 10 and 15.

Liu and Andricacos do not disclose, suggest, or teach the claimed invention recited in claims 2-3, 6, and 8-19, as amended. Accordingly, Applicant respectfully requests withdrawal of the rejection of claims 2-3, 6, and 8-19 under 35 U.S.C. § 103(a).

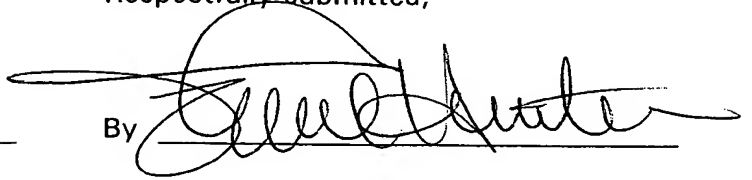
Applicant believes that the present application is now in condition for allowance. Favorable reconsideration of the application as amended is respectfully requested.

The Examiner is invited to contact the undersigned by telephone if it is felt that a telephone interview would advance the prosecution of the present application.

Respectfully submitted,

Date November 19, 2003

By

A handwritten signature in black ink, appearing to read "Paul S. Hunter", written over a horizontal line.

FOLEY & LARDNER

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Telephone: (608) 258-4292

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Paul S. Hunter

Attorney for Applicant

Registration No. 44,787

EXHIBIT B

MEMORY TRANSMISSION REPORT

PAGE : 001
 TIME : MAR-10-04 11:09AM
 TEL NUMBER: +
 NAME : Foley & Lardner LLP Madison

FILE NUMBER : 456
 DATE : MAR-10 11:06AM
 TO : 1669#999700#0301#15712731670#
 DOCUMENT PAGES : 013
 START TIME : MAR-10 11:06AM
 END TIME : MAR-10 11:09AM
 SENT PAGES : 013
 STATUS : OK

FILE NUMBER : 456

*** SUCCESSFUL TX NOTICE ***

FOLEY

FOLEY & LARDNER LLP
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Total # of Pages 13 (including this page)

TO:	PHONE #:	FAX #:
Lynn Gourley, Examiner U.S. Patent and Trademark Office	571-272-1670	571-273-1670

From : Paul S. Hunter
 Email Address : phunter@foley.com
 Sender's Direct Dial : 608.258.4292
 Date : March 10, 2004
 Client/Matter No : 999700-0301
 User ID No : 1669

MESSAGE:

Attached please find a copy of the Amendment Transmittal and Response that we filed with the U.S.P.T.O. on November 19, 2003.

Thank you for your prompt attention.

If there are any problems with this transmission or if you have not received all of the pages, please call .

Operator:	Time Sent:	Return Original To: Deanne R. Sharpe
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